ATF2

Magnets

Design and Production Status of New ATF2 Magnets

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New Magnets Being Made for the ATF2 : Overview

- **29 new FF and extraction line quads ("QEA")** been made by IHEP, Beijing and measured at KEK. Mika Masuzawa will report on measurements in this session
- **3 new dipoles B1,B2,B5** to be made: all one style.
- **5 new sextupoles** are needed: 3 in the FF: SD4, SF5 and SF6 and 2 in the "final doublet" (FD) (interleaved with final 2 quads): SF1 and SD0
- **2 new FD quads :** QF1 and QD0
- NEW skew quads (heard about at dinner last night!)

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New Magnets Being Made for the ATF2: Philosophy & Constraints

- In general we are taking steps to minimize the cost of the new magnets and to produce them in timely way (goal: all new magnets at KEK by end October 2007)
  - Using existing magnets
  - Using existing magnet movers
  - Modifying existing magnet designs
- Constraints on magnet sizes, apertures, coil ends, operating currents & voltages, from:
  - Fit in with existing movers
  - Beam height from floor of 1.2 m
  - Interface with 2 different styles of BPMs
  - Fit in with new power supply's current & voltage

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New design for dipoles, B1,B2 & B5 : based on old PEPII dipole

- **Magnet Parameter** **Requirement/Design Value**
  - Effective length 61.28 cm
  - Full gap 3.81 cm
  - Maximum $\int B.dl$ (B5's value) 2.215 kG-m
  - Max field in gap (B5's value) 3.615 kG
  - Sextupole tolerance at 1cm 2.55×10^{-04}
  - Solid C1008 steel core 57.47 cm long
  - Water cooled Cu coils 36 turns; 8.64mm sq
  - Maximum current/voltage 154 amps/5.87 V
  - Predicted sextupole (POISSON) 6.85×10^{-05}

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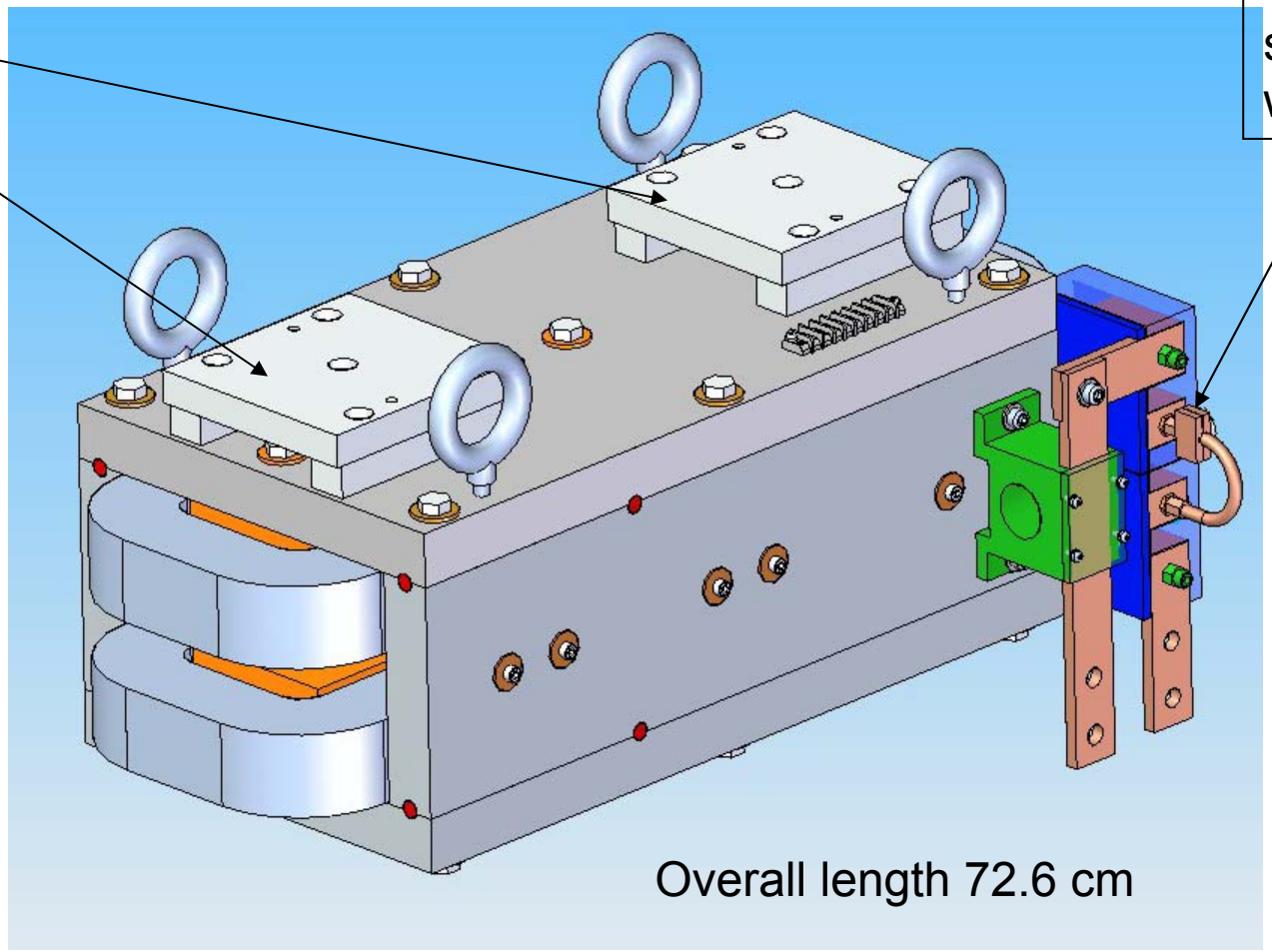
Design of ATF2 dipole: 3D figure

Bases for alignment tools

Thermal switch; one water circuit



Magnet can be split for installation in the beam line & precise re-assembly

Power terminals oriented to receive power cables from floor

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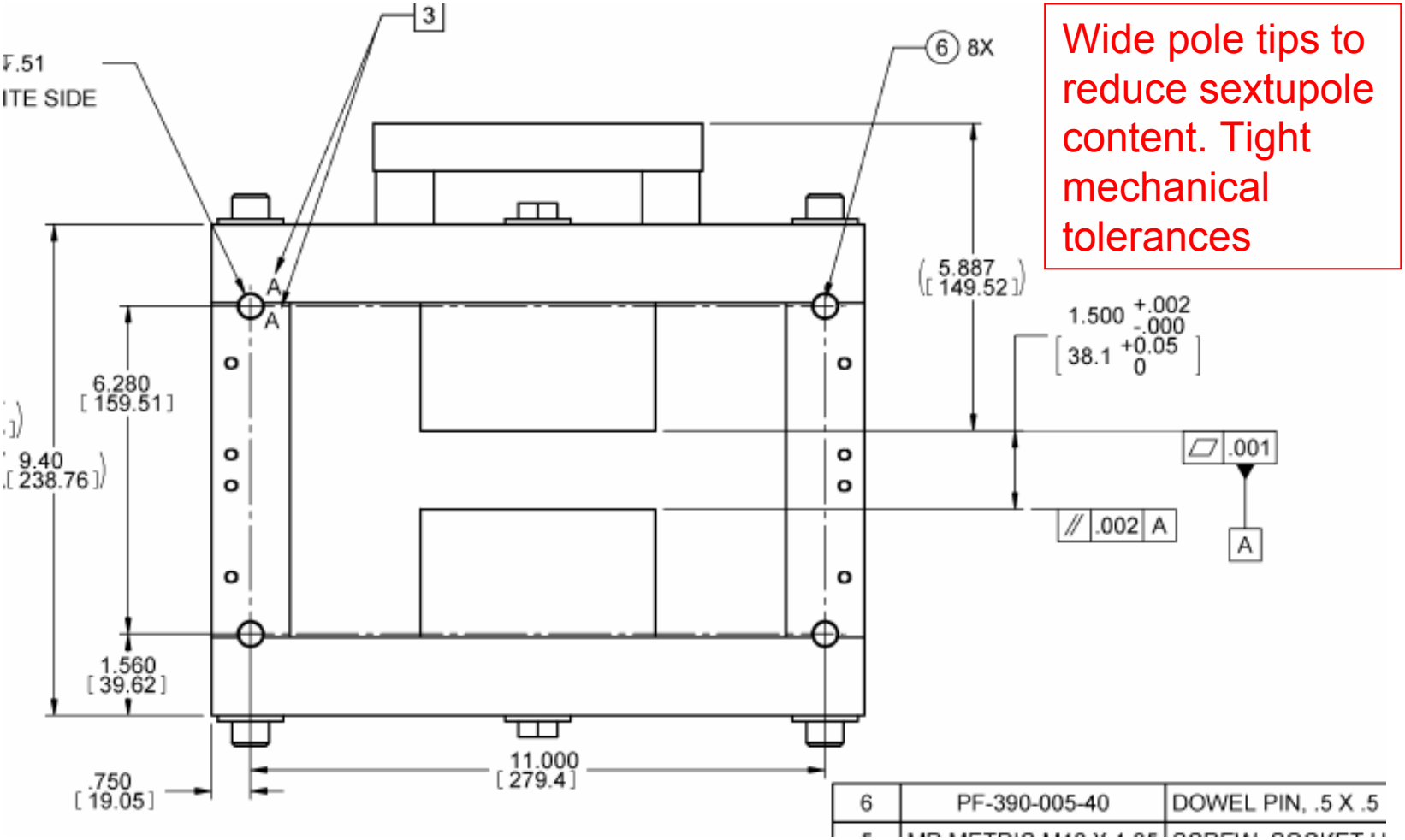
Part of ATF2 dipole core assembly drawing [inches (mm)]



Wide pole tips to reduce sextupole content. Tight mechanical tolerances

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Status of ATF2 B1,B2, B5 dipoles

- Since last project meeting (May 2006)
  - New design modelled in POISSON to achieve small enough sextupole content; reviewed
  - Detailed drawing package generated; reviewed
  - Manufacturing specifications for coils, core & magnet assembly written
  - 3 potential USA magnet vendors identified
  - Statement of work written; pre-purchase order paperwork done
  - Request for bids should go out this week

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At February 2006 ATF2 project meeting my design suggestion for Final Doublet Quads was accepted

- QF1 and QD0 requirements:
- Definition of K1 :

  Gradient = K1 x Brho / Effective length

  At 1.3 GeV, Brho = 4.3363 Tesla-meter

Latest requirements are:

- QF1 K1 = 0.737 and QD0 K1= -1.351
- These can be met using the “QC3” style FFTB quad [1.38Q17.72] of which 2 are available
- Original aperture: 35.06mm diameter ; Eff L= 0.4675m;
- Aperture needs to be larger to match S band BPM
- Effective length varies with aperture value

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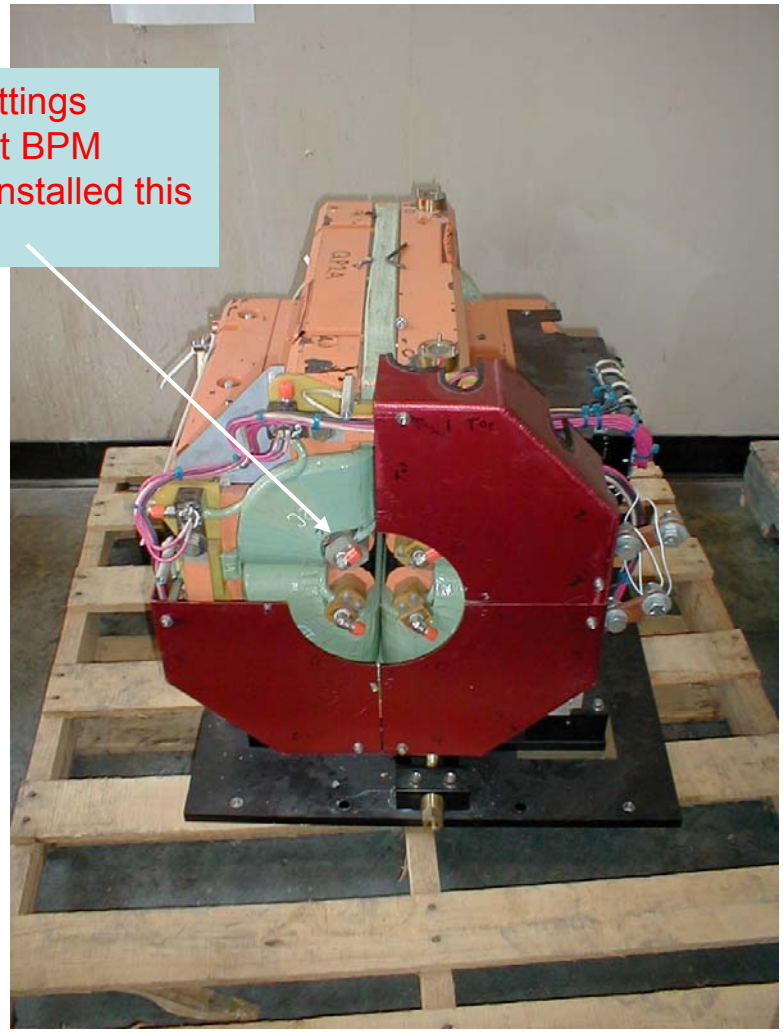
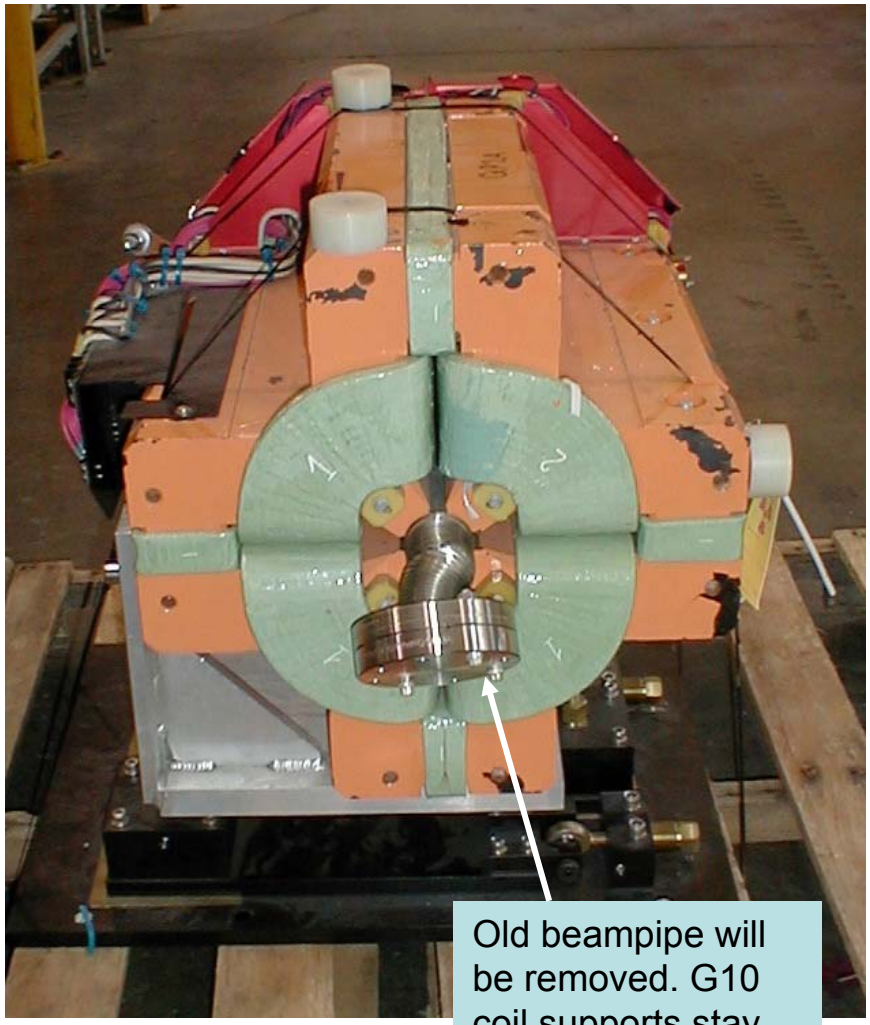
Views of both ends of QC-3 as sits in SLAC warehouse waiting for modification





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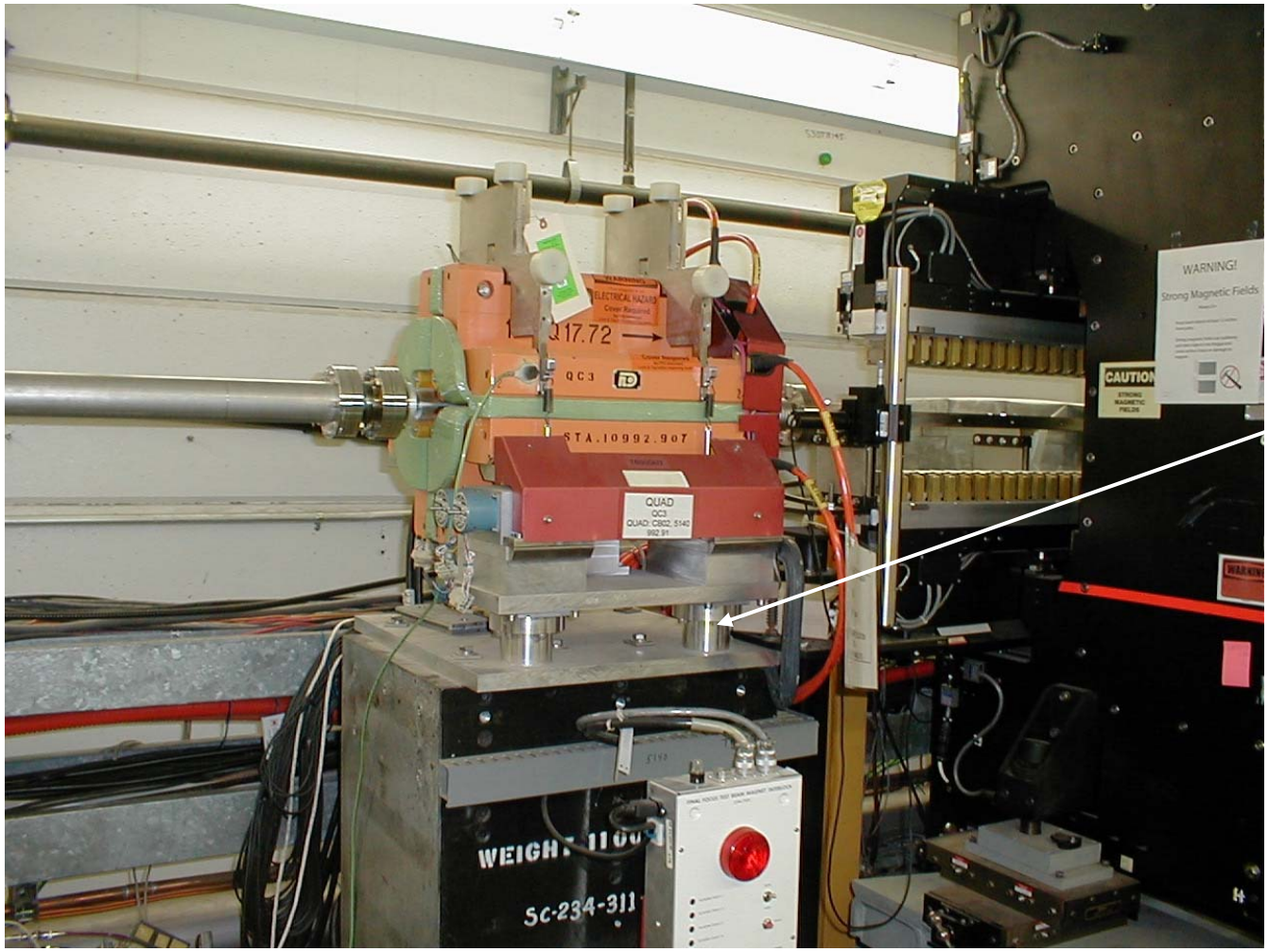
FFTB “QC3” as it was in SLAC FFTB beamline Sitting on a FFTB magnet mover



This support has to be re-designed to be much shorter, so magnet center will be at desired height in ATF2.

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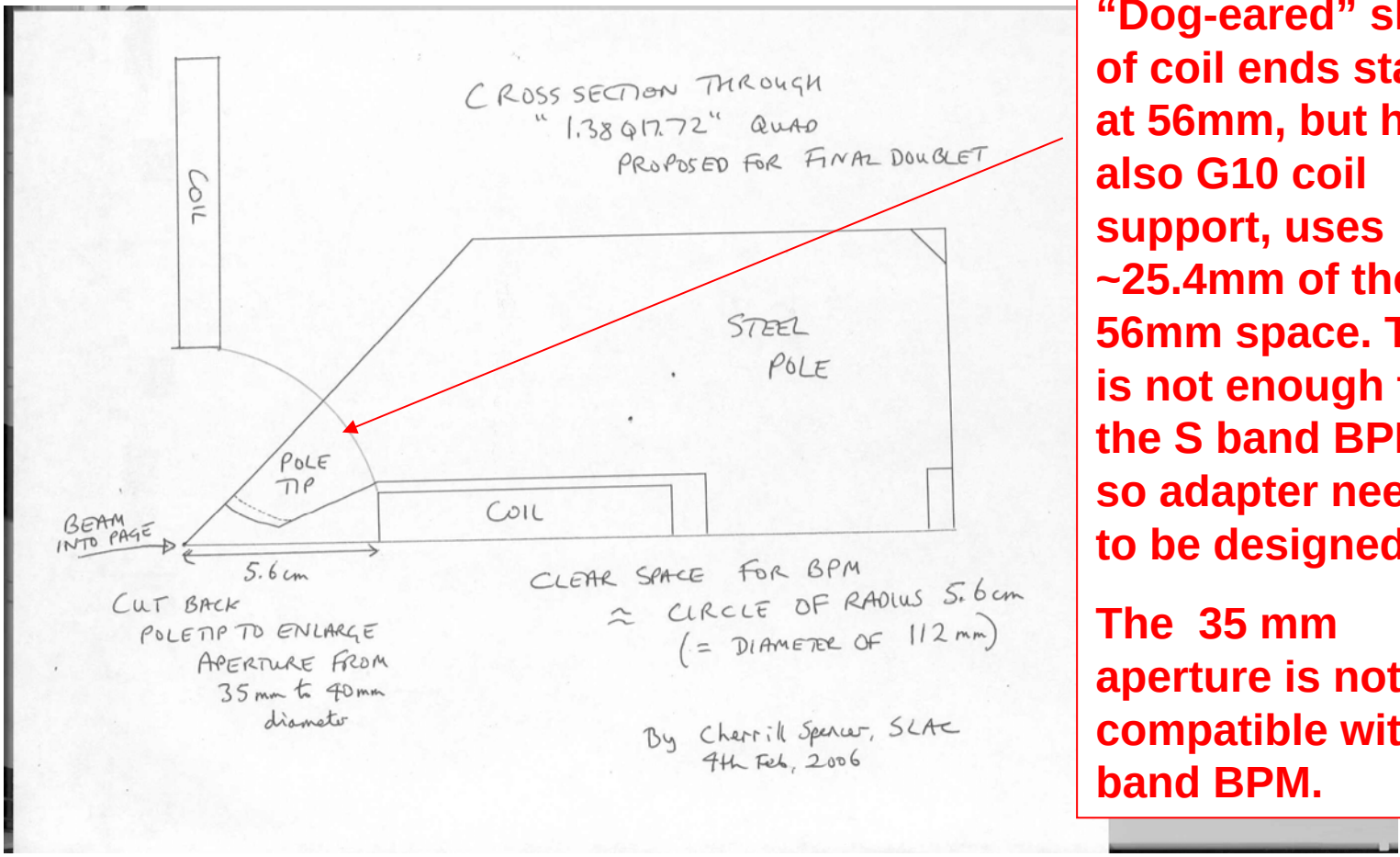
Shape of pole tip and coil in the 1.38Q17.72 quad. Will machine pole tip to make larger aperture



"Dog-eared" shape of coil ends starts at 56mm, but have also G10 coil support, uses ~25.4mm of the 56mm space. This is not enough for the S band BPM, so adapter needs to be designed.

The 35 mm aperture is not compatible with S band BPM.

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Two old FFTB quads: 1.38Q17.72. are ready to have their poletips machined back to become QD0 & QF1

- After several discussions decided to make bore aperture 50mm:
  - quad bore diameter= 40 + 2x 3.5 + 2x 2 = 50 mm 3.5mm=Cu beampipe thickness; 1mm= free space
  - have modelled in POISSON, see next slide for multipoles
- Solid steel core
- Water cooled coils, 24 turns of 0.255" sq hollow Cu conductor; 2 water circuits per coil.
- Predicted currents and voltages:
  - QD0: 127.9 amps, 8.85 volts, ΔT= 1.77 degrees C
  - QF1: 69.8 amps, 4.88 volts, ΔT= 0.53 degrees C
- STATUS: Identified machine shop with Electric Discharge Machine (EDM) that can machine back the poles (at LBNL), will send quads there in January 2007

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Compare predictions of multipole content with tolerances from James Jones & S. Kuroda

Magnet Name	Tolerance 6 pole/quad At r=1cm	Tolerance 12 pole/quad	POISSON Prediction 12pole/quad	Tolerance 20pole/quad	POISSON Prediction 20pole/quad
QF1	9.5×10^{-5}	2.46×10^{-4}	1.08×10^{-4}	1.19×10^{-3}	2.57×10^{-6}
QD0	5.26×10^{-5}	3.08×10^{-3}	1.08×10^{-4}	5.98×10^{-1}	2.57×10^{-6}

Tightest tolerance is 12pole/quad for QF1. POISSON often under-predicts multipole value, we have 2.3 times margin. But if 12pole is too large we have at least 2 ways to reduce it: by chamfering poletip ends or by adding steel buttons on poletip end; Determine the button size and position by experiment (Spencer has done this successfully for SLC DR quadrupole)

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Issue of fitting the 2 “FD” quads and 2 “FD” sextupoles on the “CLIC” table

- Was worked on in detail at a special meeting at LAPP in Annecy, France in October. A session this afternoon will deal with the IP configuration further.
- We concluded that all 4 magnets and their movers would fit on the CLIC table and the “QC3” mover assembly would have to be modified so that the center of the magnets’ bores would sit at 1.2 m off floor. CLIC table is 0.874m tall (same, on or off)

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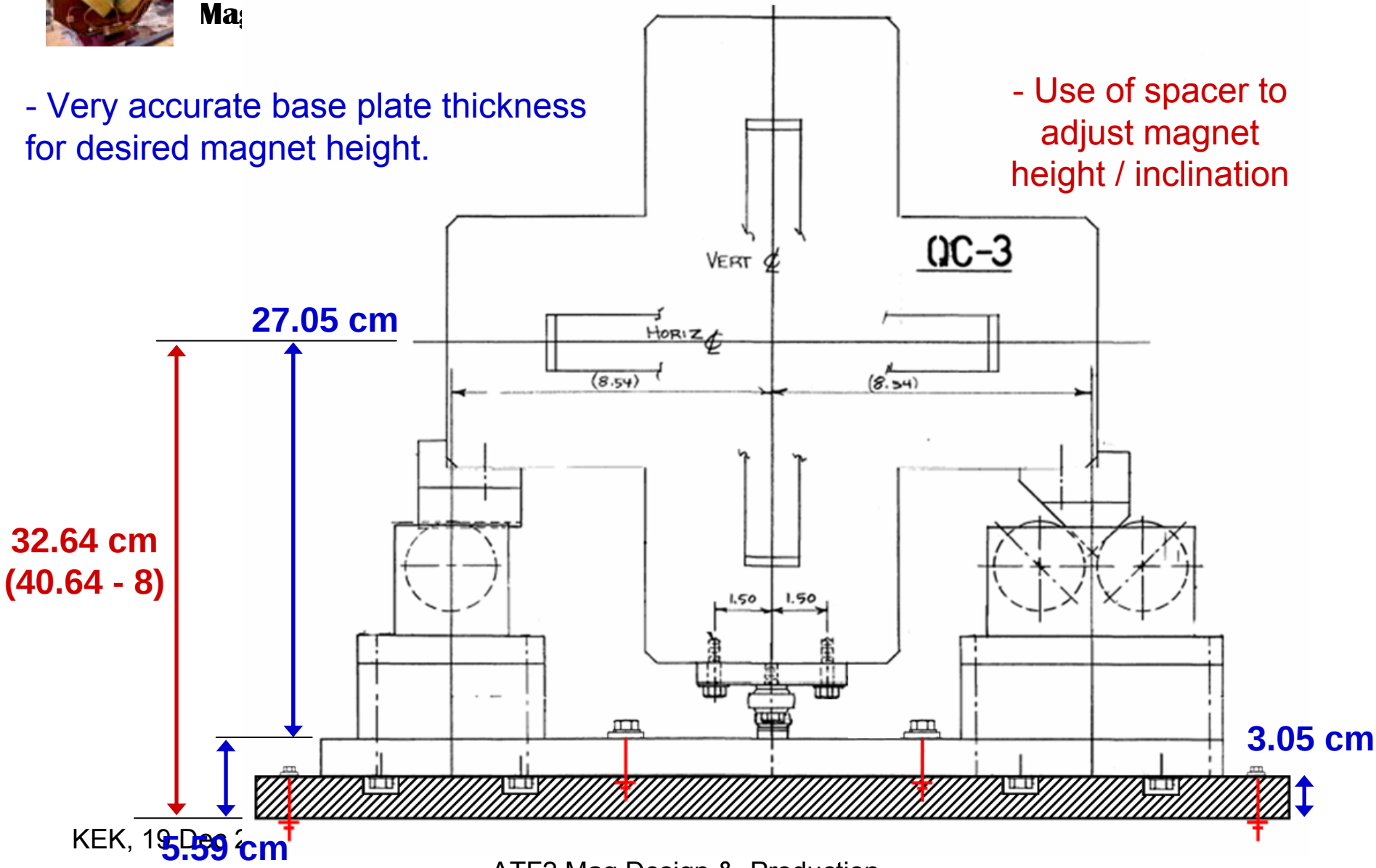
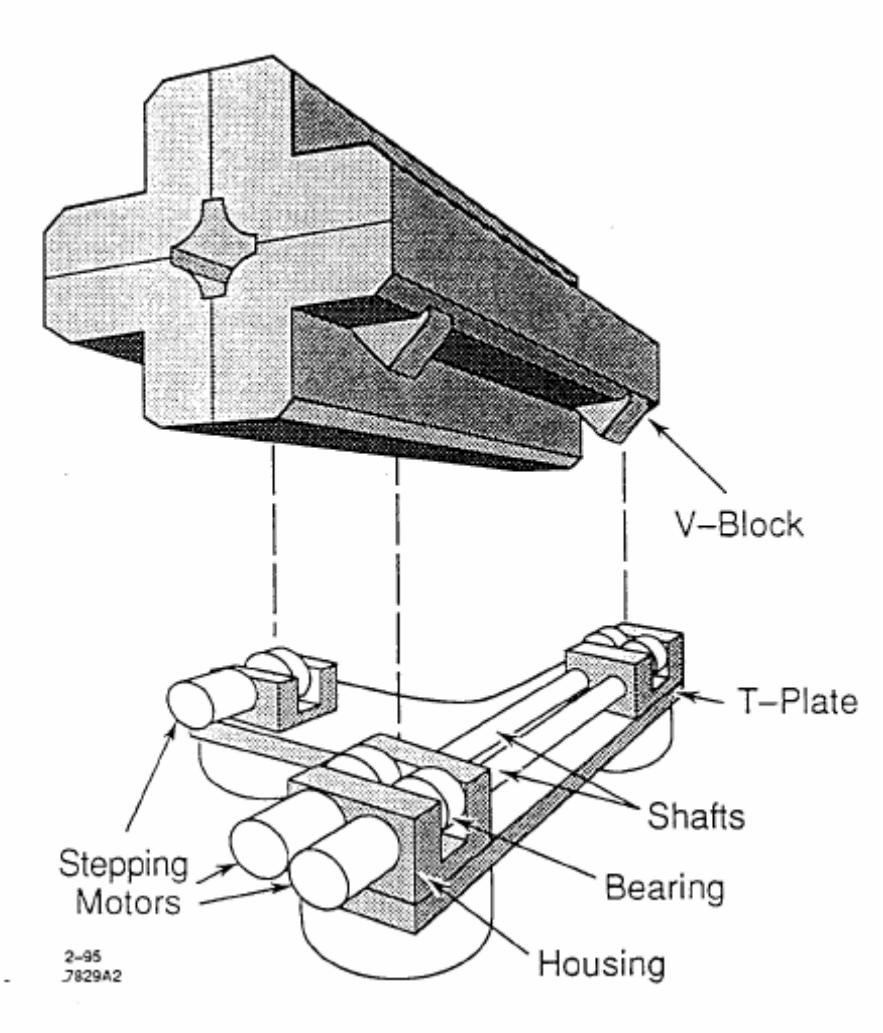
New design for wide mover support by N. Geffroy, LAPP.
With two possibilities for height adjustment

- Very accurate base plate thickness for desired magnet height.

- Use of spacer to adjust magnet height / inclination



Conceptual Sketch of an FFTB magnet mover- using V blocks to connect quad directly with mover



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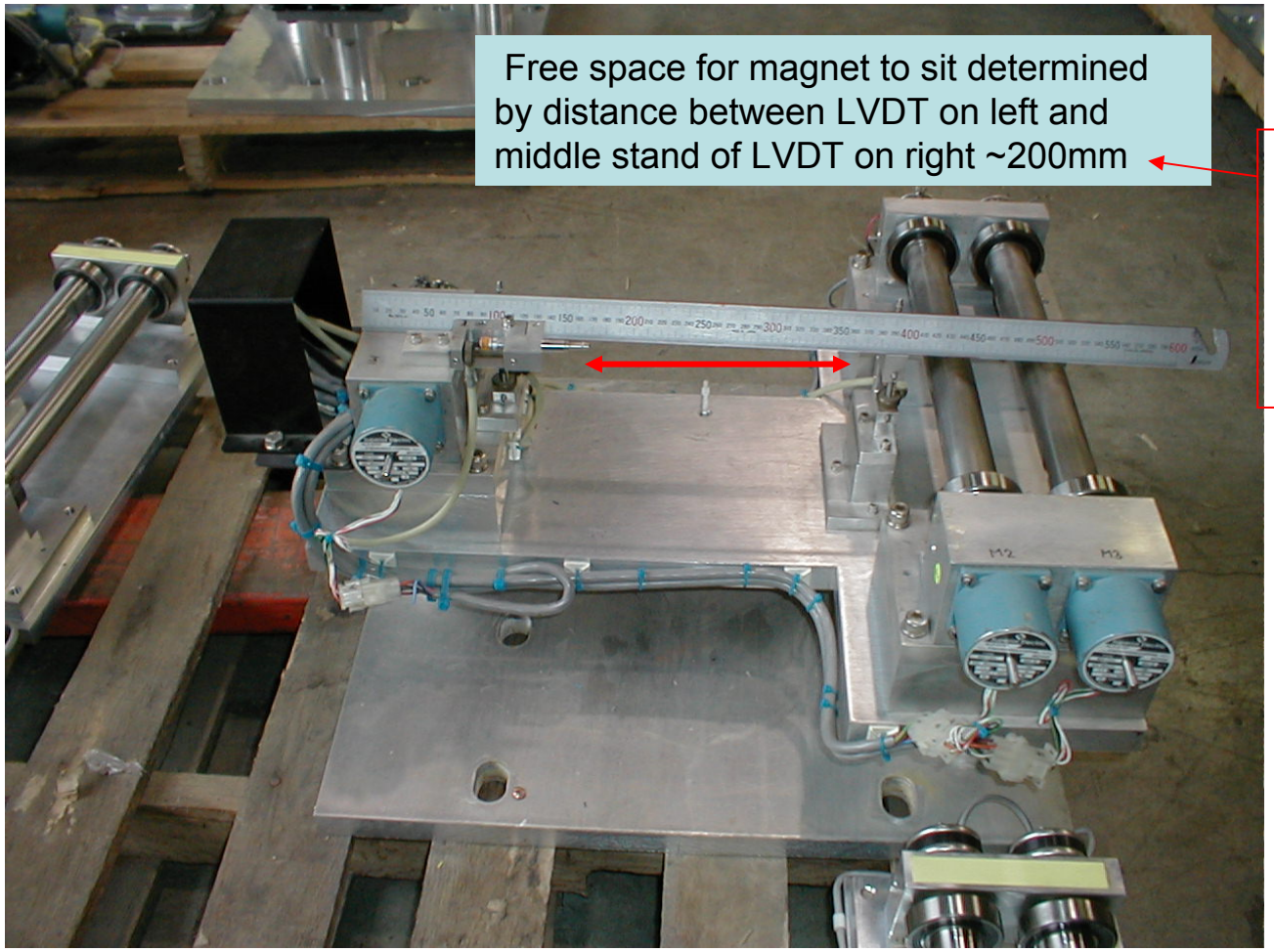
FFTB MOVER: was under QC3

Width of this QC3 mover is 609.6mm

There is only ONE QC3 style mover. Need 2.

Will have to make a 2nd one with a new T plate and use mover parts from a standard mover



This dimension is 140mm on smaller movers

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Status of the 5 new ATF2 sextupoles

- **Five new sextupoles** are needed: 3 in the FF: SD4, SF5 and SF6 and 2 in the "final doublet" (interleaved with final 2 quads): SF1 and SD0.
- Considerations of available Z space and height of ATF2 beam lead us to make new and different designs for the FF and FD sextupoles.
- **SF1 & SD0 constraints**:
  - will have (large) S-band BPMs attached to their core
  - their bore should match the QD0/QF1 bore (= 50 mm)
  - Cores can be somewhat longer than 90mm [am concerned about shortness of core relative to bore: fringe field effects]
  - their cores need to fit in with an FFTB mover & must put center of bore at 1.2m from floor
  - Current to be less than 50 amps, voltage less than 30 volts

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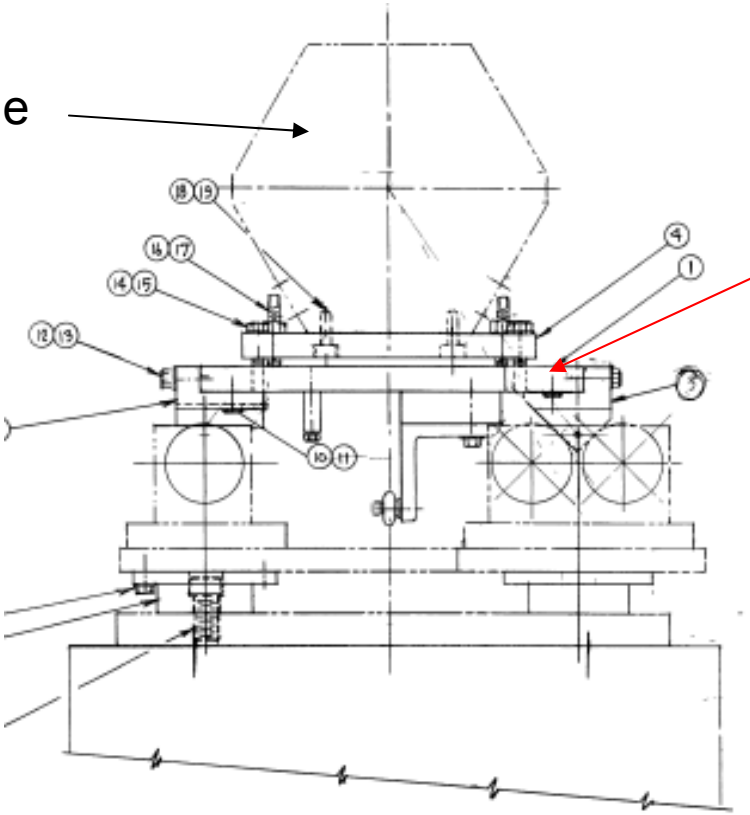
Drawing showing how other magnet style sits on an FFTB mover

Other magnet style



Put extra plates to lift up magnet as it does not fit between the shafts

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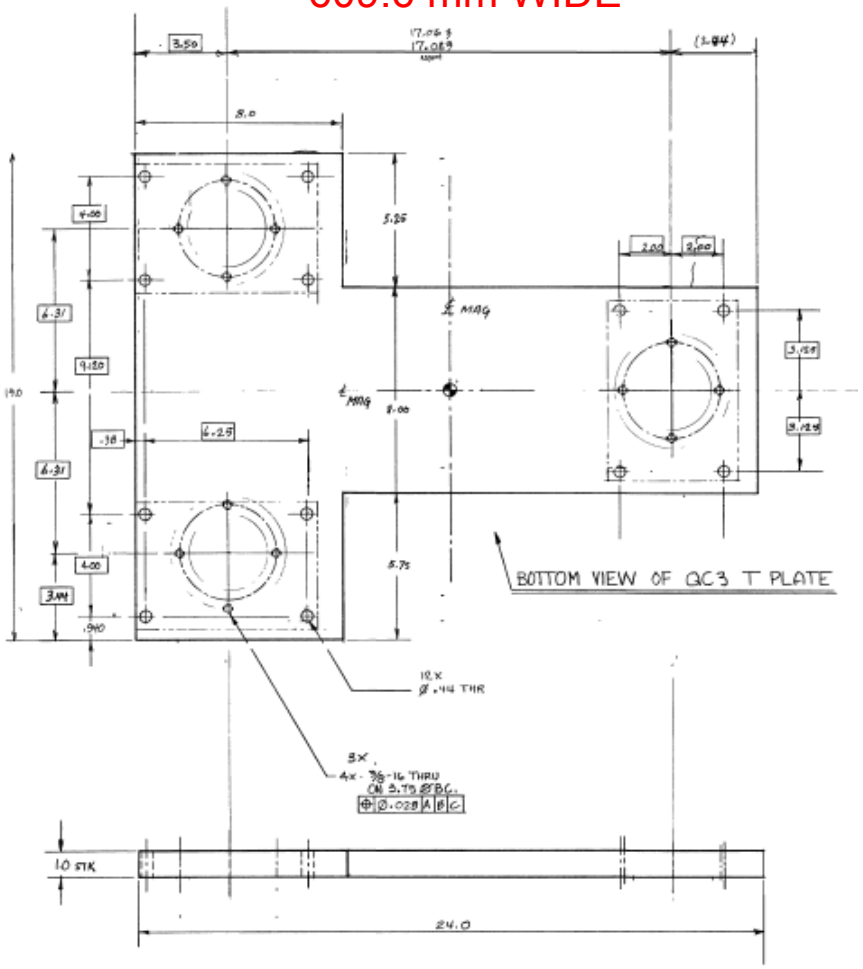
T-1 plate for QC-3, sits under FFTB mover. We have only one QC-3 T plate: for QF1

609.6 mm WIDE

482.6mm LONG



Need to make at least one more wide T plate for QD0.

If FD sextupoles width demands it will need 2 additional wide T plates for them.

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Status of the 5 new ATF2 sextupoles, continued

- **FF sextupoles**: another new design needs to be made with these features:
  - Bore to be same as adjacent QEA quads: 32 mm diameter
  - Coil end shape to be compatible with a C-band BPM
  - Core to be ~90mm long (OK with a 32 mm bore)
  - Bottom of core to be flat, to sit directly on a “QMAG” mover T plate. Distance between core bottom and bore center to be 295mm
  - Vertical distance between bottom of T plate (under a mover) and magnet bore center to be 541 mm.

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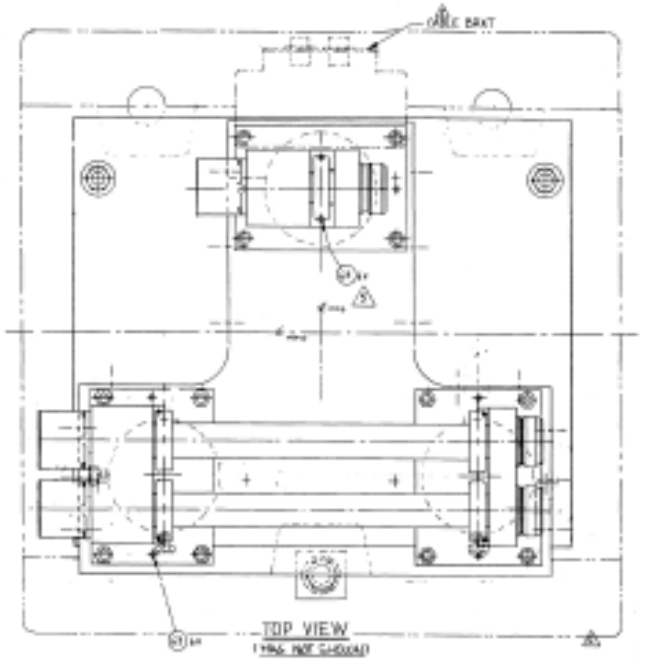
Drawings of smaller T-plate that we will be using under QEAs and FF sextupoles

Width 457.2mm



Length 482.6mm

If need wider movers: would make new T plates and use shafts, stepper motors, LVDTs etc from QMAG movers to finish the wider mover.

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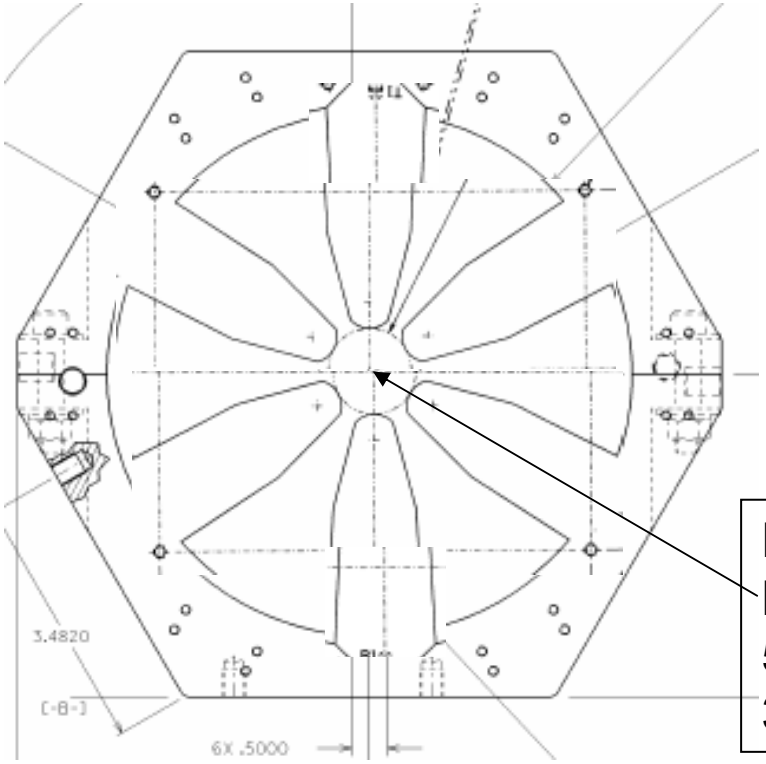
Idea for the FF and FD sextupoles

Proposed core shape- with flat bottom. Size would differ for the 2 styles

Calculations indicate that coils can be designed to meet PS requirements and have desired integrated strengths.



Actual models will be developed in January 2007 and run in POISSON.

Goal : all new magnets to be delivered to KEK by October 31st 2007.

Proposed Core shape.
Bore apertures:
50mm for SD0/SF1
32 mm for SD4,SF5,SF6

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Movement of old FFTB movers & outstanding issue

- Sending 24 less wide movers & their electronics and cables to KEK already
- Sending one wide mover and 3 less wide movers & their electronics and cables to LAPP this week (I hope)- several month loan. Will eventually come to KEK.
- Need an adjustable stand under the dipoles- who to design and build?